Final Year Project Showcase Batch-2019
Year 2023

Department: Metallurgical Engineering Programme: Metallurgical Engineering	
1	**Project Idea** To investigate the impact of retrogression and re-aging heat treatments on the impact strength and corrosion properties of aluminum alloy (Al-7075).
2	**Process** Solution treatment, aging, retrogression, and re-aging heat treatments are involved.
3	**Outcome** By elevating the retrogression temperature, the corrosion resistance of the samples was augmented, leading to improvements in mechanical properties such as increased impact strength and reduced hardness.
4	**Evidence (Theoretical Basis)** The Aluminum 7075 (Al-7075) alloy, renowned for its impressive strength-to-weight ratio, has gained significant prominence in various industries. However, a persistent challenge remains in simultaneously improving its mechanical properties while preserving its inherent corrosion resistance. This challenge serves as the central focus of our project. Traditional heat treatments, like the T6 and T7 tempers, have been employed to enhance the mechanical characteristics of Al-7075 alloys. Nonetheless, these treatments can sometimes result in a trade-off between strength and corrosion resistance. To address this issue, we employ the retrogression and reaging (RRA) treatment method to tailor the alloy's properties by strategically controlling the formation of precipitates and grain size. By varying retrogression temperatures and durations, this study delves into their intricate impact on hardness, impact strength, and corrosion resistance. These outcomes can be attributed to the deliberate interactions among particles ($MgZn_2$, Al_2CuMg) and the precise management of grain size. Additionally, it was observed that by elevating the retrogression temperature, the corrosion resistance of the samples was augmented, leading to further improvements in mechanical properties, such as increased impact strength and reduced hardness. This research contributes to an improved understanding of RRA's influence on aerospace alloys and Al-7075, paving the way for optimized alloy performance.
5	**Competitive Advantage or Unique Selling Proposition** In this FYP work, the following aspects have been fulfilled: A: Competitive Advantage: • The project focuses on achieving a competitive advantage by improving the mechanical properties of Aluminum 7075 alloy while preserving its corrosion resistance. • The use of retrogression and reaging (RRA) treatment method strategically enhances the alloy's characteristics, offering a unique approach compared to conventional heat treatments like T6 and T7 tempers. • By elevating the retrogression temperature to augment corrosion resistance and enhance mechanical properties, the project demonstrates a novel way to tailor alloy performance. • This competitive advantage makes the FYP appealing to the aerospace industry and other sectors seeking improved alloy performance. B: Unique Selling Proposition (USP):

	• The project's unique selling proposition lies in its ability to address the challenge of simultaneously enhancing mechanical properties and corrosion resistance in Aluminum 7075 alloy. • The RRA treatment method offers a distinct approach to achieving this balance, making it a compelling solution for industries that rely on this alloy. • By providing a detailed understanding of how retrogression temperature affects corrosion resistance and mechanical properties, the FYP offers valuable insights that can drive investment and adoption in the industry. The project's competitive advantage and unique selling proposition stem from its innovative approach to improving alloy performance, making it an attractive investment for industries seeking superior materials for their applications
a	**Attainment of any SDG** (e.g. How it is achieved and why it is necessary for the region) **SDG#09: Industry, Innovation and Infrastructure** This project fulfills the aspect of "Attainment of an SDG," specifically SDG 9: Industry, Innovation, and Infrastructure. Here's how it is achieved and why it is necessary for the region: Achievement of SDG 9: • The project aligns with SDG 9 by optimizing heat treatment processes, which actively contribute to the development of sustainable infrastructure and promote resource efficiency in industrial practices. • It showcases innovative approaches in materials science and leverages technological advancements to achieve microstructural modifications, which are essential for sustainable manufacturing practices. • Through knowledge sharing and capacity building, the project aims to facilitate the dissemination of insights and promote the adoption of sustainable industry practices in the region. Why it is necessary for the region: • Achieving sustainable industry, innovation, and infrastructure is crucial for the region's economic growth and long-term development. • By optimizing heat treatment processes and promoting resource efficiency, the project helps reduce waste and energy consumption, leading to cost savings and environmental benefits. • The project's focus on sustainable manufacturing practices aligns with global sustainability goals and contributes to a more environmentally friendly and economically viable industrial sector in the region. In summary, the project's alignment with SDG 9 underscores its commitment to sustainable industry, innovation, and infrastructure, making it a valuable initiative for the region's economic and environmental well-being.
b	**Any Environmental Aspect**(e.g. carbon reduction, energy-efficient, etc.) The project has not directly studied environmental aspects such as carbon reduction or energy efficiency.
c	**Cost Reduction of Existing Product** Optimizing heat treatment processes and adopting sustainable manufacturing practices, it enhances resource efficiency, lowering production costs. The project's focus on innovation and technology advancements can lead to more efficient production methods, reducing labor and material expenses. Knowledge sharing and capacity building contribute to a skilled workforce, reducing errors and improving product quality, ultimately driving long-term cost savings.

d	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency** **Improvement of the Whole Process** (e.g. What is the issue is current process and what improvement you suggests) For improvement in the process, the following measures are suggested; • Use advanced techniques like TEM for deeper microstructural understanding. • Extend corrosion analysis to marine environments through exposure tests in simulated seawater. • Perform SCC tests to assess the material's susceptibility to stress corrosion cracking. • Conduct tensile and fatigue tests for mechanical properties evaluation. • Optimize heat treatment parameters, compare with other alloys, and study long-term behavior for better insights
e	**Expanding of Market share** (e.g. how it expand and what is the problem with the current market Expanding the market share of aluminum alloy 7075 with retrogression and re-aging heat treatment in Pakistan can be achieved by collaborating with local industries and manufacturers to showcase its benefits, emphasizing its ability to meet the country's growing demands for high-strength and corrosion-resistant materials. However, a challenge lies in educating potential users about the advantages of this alloy, which may require targeted marketing campaigns and technical support to demonstrate its suitability for various applications. Addressing supply chain and pricing issues to ensure competitive availability will also be vital for successful market expansion.
f	**Capture New Market** (e.g. Niche market or unaddressed segment) To capture a new market for aluminum alloy 7075 with retrogression and re-aging heat treatment in Pakistan, companies should consider targeting niche segments or unaddressed industries. For example, focusing on emerging sectors like renewable energy infrastructure, where high-strength, lightweight materials are essential, could open up new opportunities. Moreover, exploring applications in specialized manufacturing processes or customized solutions for specific industrial needs can help penetrate untapped markets. Collaborating with local partners and offering tailored solutions will be key to successfully entering these niche or unaddressed segments.
g	**Any Other Aspect** In addition to the mechanical properties and corrosion resistance improvements, another aspect of applying retrogression and re-aging heat treatment to aluminum alloy 7075 in Pakistan is its potential contribution to sustainability and resource efficiency. By optimizing this heat treatment process, manufacturers can reduce energy consumption and material waste, aligning with sustainable manufacturing practices. This aspect can be particularly relevant in Pakistan's industrial landscape, where eco-friendly and resource-efficient solutions are gaining importance, thus promoting a more environmentally responsible approach to alloy production and usage.
6	**Target Market** (Industries, Groups, Individuals, Families, Students, etc) Please provide some detail about the end-user of the product, process, or service The target market for aluminum alloy 7075, subject to retrogression and re-aging heat treatment, primarily consists of industries and businesses in need of high-strength, corrosion-resistant, and lightweight materials. This includes aerospace manufacturers, defense and military entities, automotive companies, marine industry players, industrial machinery manufacturers, and sporting goods producers. The end-users are typically professionals and organizations requiring components or equipment with specific performance characteristics, such as aircraft designers, military personnel, automotive engineers, marine engineers, and industrial machinery operators
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10	**Pictures (If any)**